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ABSTRACT

Reported is a study representing a chronological history of selected objectives for the teaching of secondary school chemistry in the United States during the 1918-1972 period. Periodical literature was the primary source of materials reviewed, consisting of "School Science and Mathematics" (1918-1972), "Science Education" and "The General Science Quarterly" (1918-1972), "The Journal of Chemical Education" (1924-1972), "The Science Teacher" and "The Illinois Chemistry Teacher" (1934-1972), "The Bulletin of the Atomic Scientists" (1945-1972), and "The Journal of Research in Science Teaching" (1963-1972). The 1918-1972 time span was divided into six subperiods: 1918-1933, 1932-1941, 1939-1946, 1945-1957, 1954-1964, and 1963-1972. (Reasons for these subdivisions are provided in the report.) The investigator identified 18 distinct types of objectives and found that, while yearly fluctuations existed for numbers of articles and statements concerned with objectives for teaching secondary school chemistry, the number of distinct objective types remained fairly constant. Sixteen of the 18 were found in literature for all 6 subperiods, no objective appeared in the literature of later subperiods that was not present in subperiod 1, 1918-1933. (Author/PEB)

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A CHRONOLOGICAL HISTORY OF SELECTED OBJECTIVES FOR THE TEACHING OF SECONDARY SCHOOL CHEMISTRY IN THE UNITED STATES DURING THE 1918-1972 PERIOD, AS REFLECTED IN PERIODICAL LITERATURE

BEST COPY AVAILABLE

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Introduction

Histories involving secondary school chemistry have been attempted by a number of persons. Works by Clarke (1) and Powers (7) were primarily concerned with beginnings. Each traced the inception and growth of the subject from earliest times until the mid-1800's (Powers until 1850 and Clarke until 1880). A study by Rosen (8), part of a project which involved other sciences as well, analyzed developments in the public high schools during the 1820-1920 period. Two other studies, one by Fay (2) and one by Osborn (6), attempted to report on the entire range in time from the first appearance of the subject until date of the writing (1930 and 1960 respectively). Although the above mentioned histories are valuable for the information they impart, none attempted to analyze periodical literature as it pertained to chemistry teaching. In the introduction to his dissertation Fay noted:

> I have attempted to reveal how and what science was actually taught, not the opinion of progressive thinkers; I have consequently, purposely neglected the great body of periodical and other matter on the teaching of science.

Studies by Hall (3) and Hurd (4) attempted to analyze trends in science teaching by utilizing a number of sources. Hall investigated chemistry teaching during the 1920-1938 period by selecting his data from committee reports, periodical literature, courses of study, and textbooks. Hurd utilized similar sources plus science education textbooks in assessing the 1895-1948 years. Although both of these studies involved the analysis of periodical literature, neither gave primary emphasis to this source and both utilized relatively few journals.

The present study attempts to build upon or extend those previously cited. While dealing generally with the history of chemistry teaching in the secondary schools of the United States during the 1918-1972 period, it is concerned with the evolution of objectives as reflected by statements in articles from selected professional periodicals. Siegfried (9) has written that the publication of periodical literature:

> is the natural end product of scientific investigation and provides a reliable index to the state of knowledge and interest of the men so engaged. The timelapse between the actual investigation and the publication is generally small, insuring a sensitive reflection of changing interest. ...Publication presupposes a receptive audience and the growth of each publication reflects the growth of the audience.

Problem

To prepare a chronological history of selected objectives for teaching chemistry in the high schools of the United States during the period 1918-1972, as reflected in selected professional periodicals.

Procedure

Selection of Subperiods

The 1918-1972 period was divided into subperiods on the basis of selected events in the social, political, or educational history of the United States. In all cases some overlapping of subperiods was planned to allow for the gradual transformation characteristic of historical change.

1. Subperiod 1 (1918-1933). Subperiod 1 extends from 1918, the beginning date of the study, through 1933. The year 1933 was selected as the termination date because the effects of the depression were not expressly felt in education until the mid-1930's and in 1933 the Progressive Education Association (PEA) began its Eight Year Study.
2. Subperiod 2 (1932-1941). The second subperiod extends from 1932, and the election of Franklin D. Roosevelt as President, through 1941, when the United States entered World War II.
3. Subperiod 3 (1939-1946). Subperiod 3 spans the 1939-1946 years, and covers the duration of World War II.
4. Subperiod 4 (1945-1957). Subperiod 4 extends from 1945 through 1957. It begins with the "Prosser resolution" and the following period of "life adjustment education" and ends with the successful launching of Sputnik I by the Soviet Union in 1957.
5. Subperiod 5 (1954-1964). Subperiod 5 begins in 1954 with mounting criticism of "life adjustment education" and ends following 1964 and growing student unrest as exemplified by the riots at the University of California's Berkely campus.
6. Subperiod 6 (1963-1972). Subperiod 6 includes the 1963-1972 years. It begins with a growing uneasiness over the first wave of post Sputnik science curriculum projects and ends following 1972, the final full year of United States involvement in Viet Nam and prior to the Watergate hearings.

Selection of Literature to be Studied

All issues of the following periodicals were read in an attempt to locate articles concerned with objectives for teaching secondary school chemistry.

1. School Science and Mathematics (1918-1972)
2. Science Education and The General Science Quarterly (1918-1972)

3. The Journal of Chemical Education (1924-1972)
4. The Science Teacher and The Illinois Chemistry Teacher (1934-1972)
5. The Bullentin of the Atomic Scientists (1945-1972)
6. The Journal of Research in Science Teaching (1963-1972)

All issues of the periodicals selected were read for relevant articles. Those selected for re-reading were chosen on the basis of the following criteria:

1. It was an expression of opinion or the result of formal research activity.
2. It was concerned with chemistry teaching at the secondary level. Articles concerned with science teaching in general were included if they used examples from chemistry or used general examples of use in the teaching of chemistry. Articles involving specific examples from subjects other than chemistry were eliminated.
3. It was concerned with chemistry teaching and not some aspect of pure chemistry. Such "informational" articles were eliminated unless specific reference was made to the possible implications for teaching.
4. It was not a committee report or a critique of a committee report.
5. It was not an editorial or a letter to the editor.

Articles were abstracted as to their stated objectives and the information and ideas expressed were recorded on cards. Each card contained a standard bibliographic reference plus notes on the content of the article.

Classification of Statements

Following a pilot study involving a search of 10 volumes of School Science and Mathematics selected at random from the period to be studied, statements were first categorized as knowledge, process, attitude and interest, and cultural awareness. Statements were then placed in subclasses on the basis of similarities and differences, an activity which resulted in the establishment of 18 distinct objective types. During this phase of the investigation no attempt was made to duplicate exactly the wording of the original authors. The subclasses were, instead, based upon common ideas or areas of concern such as "scientific methods of thinking" or "the nature of science and scientists". Categories and subclasses were defined as follows:

1. Knowledge objectives as determined from the data are those advocating the attainment of factual or conceptual material for its own sake or for its functional value and those stressing knowledges and skills basic to the study of chemistry. Types of objectives typical of this category are:

a. "Specific topics in chemistry" - statements advocating the study of specifics such as ionization, equations and reactions, or atomic structure. Examples are those calling for the study of:

(1) ionization,

(2) valence,

(3) equation writing,

(4) the conductivity of fused salts, or

(5) the gas laws.

b. "Major facts, principles, concepts, or fundamentals" - objectives of this type are less detailed than those relating to the study of "specific topics..." and usually involve more than one example. Examples of this type are:

(1) to teach principles or foundations,

(2) to develop understanding of fundamental facts,

(3) to distribute knowledge,

(4) to inculcate facts,

(5) to develop an understanding of principles and natural laws,

(6) to give broad training in fundamentals,

(7) to develop quantitative relationships,

(8) to develop conceptual schemes, or

(9) to cultivate general understandings.

c. "The applications of chemistry to daily life" - these objectives tend to call for the application of the concepts or fundamentals of chemistry to life situations and are specific in that examples are often provided. Examples of this objective stress:

(1) skill in applying the principles of chemistry,

(2) practical industrial or household uses of information,

(3) the ability to use chemistry to solve life problems, or

(4) intelligent consumership.

d. "A fund of useful information" - these objectives, although similar to c, stress the accumulation of a body of knowledge, not its application. Examples are:

(1) to give information of service to home and daily life,

(2) to acquire functional information,

(3) to give the student accurate scientific information, or

(4) to acquire a body of reliable and useful information.

e. "Study skills" - objectives of this type tend to stress knowledges and skills necessary for the successful study of chemistry. They include use of proper nomenclature and vocabulary, mathematical skills, and study habits. Typical examples include:

(1) use of accepted nomenclature,

(2) the development of more exact terms to enlarge vocabulary,

(3) to develop the use of geometry in solving problems, or

(4) to encourage the use of applied mathematics.

2. Process objectives are those conveying an understanding and use of the methods and techniques of science. Statements included advocated skills in critical thinking and in problem solving as well as in the "processes" of observing, classifying, inferring, predicting, measuring, communicating, interpreting data, making operational definitions, formulating questions and hypotheses, experimenting and formulating models (10). Types of objectives in this category are:

f. "Scientific methods of thinking" - these objectives deal with thinking skills and methods of thinking as outcomes of instruction in chemistry. Statements of this type tend to stress the development of critical thinking and problem solving abilities. Some examples are:

(1) to provide training in new ways of thinking,

(2) to stimulate thinking,

(3) to provide training in the scientific method of thinking,

(4) to develop the ability to reason,

(5) to improve thinking ability,

(6) to develop critical thinking,

(7) to give training in methodological thinking, or

(8) to encourage scientific thinking.

g. "Processes, skills, and techniques of inquiry" - statem of this type are more functionally oriented than in f. The deal specifically with the techniques involved in employing the processes and methods of scientific problem solving. Examples are:

(1) to develop the ability to ask and answer questions

(2) to observe accurately,

(3) to train in laboratory techniques,

(4) to develop skill in collecting and interpreting da

(5) to develop skill in the use and handling of equipment, or

(6) to provide experiences in the process of getting information.

h. "Research and creativity" - these statements are concer with developing the capacity to do research. As such, they differ from f and g in their degree of specificity and for this reason are considered alone. Typical examples are:

(1) to stimulate creative thinking,

(2) to do research,

(3) to teach creativity, or

(4) to develop the capacity for doing research.

3. Attitude & Interest objectives are those concerned with developing an appreciation of the contributions of and nature of the scientific enterprise, desirable attitudes involving science and scientists, and lasting professional and avocationa interests in students. Types of objectives are:

i. "Scientific habits or attitudes" - statements typical o this type of objective convey a willingness upon the part o the individual to use a scientific method of solving proble in everyday affairs. Aspects of the objectives are concern with the formation of correct habits of thinking involving the ability and inclination to recognize a problem, conside evidence, suspend judgement, change an opinion, and other general indications of "scientific mindedness". Examples a

(1) to develop scientific attitudes,

(2) to encourage the habit of using thought effectively in dealing with facts,

(3) to encourage the desire to know,

(4) to develop openmindedness,

(5) to provide for character formation,

(6) to encourage scientific mindedness,

(7) to inculcate healthy attitudes, or

(8) to assist in the development of a value system.

j. "Appreciations" - these objectives carry an awareness and acceptance of the products and processes of science as they relate to life situations. They are on a more personal level than those involved with cultural implications and involve individual responses to the contributions of chemistry to daily living. Typical examples are:

(1) to develop an appreciation of the history of chemistry,

(2) to appreicate scientific and technological advances, or

(3) to develop an appreciation of the scientific method.

k. "Interest and hobby development" - objectives of this type involve the development of non-career interests. Avocational pursuits such as photography or merely an interest in science reflected in a willingness to read about developments in chemistry are considered. Examples are:

(1) to encourage interest,

(2) to open new areas of interest and satisfaction,

(3) to encourage hobbies and leisure time activities,

(4) to maintain and promote interests, or

(5) to kindle enthusiasm.

l. "Career development" - objectives relating to pre-professional or vocational training, such as those calling for the development of future scientists and technicians are treated separately from those concerned with interest or hobby development (k). The level of interest is more clearly specified and careers are definitely stated as the end product. Examples are:

(1) to find future scientists,

(2) to sell science,

(3) to encourage science as a means of livelihood,

(4) to give better vocational advice and choices,

(5) to help students develop aptitudes,

(6) to find and help the superior or gifted student,

(7) to develop and encourage vocational abilities,

(8) to provide vocational guidance,

(9) to provide workers, or

(10) to develop future scientists and technicians.

m. "The nature of science and scientists" - objectives of this type are concerned with the attainment of a realistic concept of the nature of science and scientists. Questions involving the workings and ethics or the scientific enterprise and those who make it function are central to this objective. Examples are:

(1) to develop an understanding of the nature of chemistry,

(2) to understand the philosophy of science,

(3) to show science as another human enterprise,

(4) to develop the understanding of science and its spirit,

(5) to provide for public knowledge of science,

(6) to understand what science is.

(7) to develop an awareness of the nature of science, or

(8) to comprehend the nature and ethics of science.

4. Cultural awareness objectives are those dealing with the interworkings of science and society or the cultural implications of science for society. Types of individual objective types are:

n. "Aesthetic aspects" - objectives stressing the humanistic and creative aspects of science are considered to be of an aesthetic nature. Some examples are:

(1) to show science as a part of culture,

(2) to develop an understanding of the human aspects of chemistry,

(3) to show the humanizing aspects of chemistry,

(4) to explore the relationships between science and humanity,

(5) to teach the cultural values of science, or

(6) to show science as an aesthetic pursuit.

o. "Philosophical considerations" - questions involving the ways in which science is influenced by the nature of society and the way science affects that society constitute philosophical objectives. Examples are:

(1) to develop a more intelligent understanding of the world,

(2) to show chemistry as a means of advancing civilization,

(3) to comprehend the contributions of chemistry to civilization,

(4) to show science as a means of social betterment, or

(5) to teach how chemistry brings about changes in the social order.

p. "Sociological implications" - objectives involved with the effects of scientific innovations on society and their results are defined as sociological objectives. Examples are:

(1) to assist in social adjustments,

(2) to develop an understanding of the social implications of science,

(3) to understand the impact of science upon society, or

(4) to develop an understanding of the relationship between man and his environment.

q. "Economic aspects" - awareness of how scientific advances influence economic development is considered to be a cultural awareness objective. Examples are:

(1) to show the economic implications of chemistry for mankind,

(2) to show how science creates an abundant life for all, or

(3) to show how chemistry has increased the standard of living.

r. "Political implications" - objectives dealing with governmental policy as a result of scientific activity and those involving public support of science are thought to be of a cultural nature and are so classified: Some examples are:

(1) to teach chemistry in light of national needs,

(2) to teach the lessons of nature as a basis for democracy,

(3) to develop a responsible citizenry,

(4) to develop an educated electorate,

(5) to compete with Russia, or

(6) to develop public awareness of science.

Analysis of Data

The information obtained was analyzed in an attempt to answer the following questions within and across subperiods:

1. What frequencies of citations were associated with each of the 18 objective types identified?
2. What major educational groups (see authorship) were involved in the writing of articles concerned with the objectives for teaching secondary school chemistry and did these groups agree or disagree in their outlook as determined by frequency rankings?

Definitions

1. Secondary education is that planned for pupils in grades nine through twelve.
2. Chemistry is the first chemistry course in secondary science.
3. Objectives are the stated outcomes, goals, or aims of instruction. The level of objective studied corresponds to what Krug (5) has called "statements for instructional fields or school subjects".
4. Authorship is an occupational categorization of the authors of articles obtained. Such authors were considered as representing secondary education, higher education, or miscellaneous backgrounds.

Results

The findings of the study are reported in Tables 1 and 2. The following summaries refer to variations in the frequencies of the nine most frequently cited objective types.

1. Statements of objectives involved with the development of "scientific methods of thinking" were among those most frequently cited during all subperiods.
2. Although not quite cited to the extent of objectives related to "scientific methods of thinking", statements stressing the understanding of the "major facts, principles, concepts, or fundamentals" of chemistry were also among the mc ' frequent during all subperiods.
3 Statements calling for the study of "specific topics in chemistry" were most prevalent in the literature of subperiods 1, 3, and 4. Following the close of subperiod 3 they steadily decreased in frequency.
4. Objectives involving the development of "scientific habits of attitudes" were most abundant during subperiods 1-4. From a position as the most often cited objective type during subperiod 2, statements of this concern have steadily decreased in frequency.
5. References to the "career development" aspect of chemistry teaching were most frequent in the literature of subperiods 4 and 5.
6. Concern for instruction in the "processes, skills, and techniques of inquiry", as indicated by the frequency of appropriate objective statements, was highest during subperiods 2, 3, and 4.
7. Objectives concerned with "the applications of chemistry to daily life" were most frequently cited during subperiods 1, 2, and 3.
8. Statements concerned with the "sociological implications" of chemistry were most frequent during the years of subperiod 6.

9. Concern for developing an understanding of "the nature of science and scientists" has steadily increased throughout the 1918-1972 years. Statements reflecting this objective were most frequent during subperiod 6.

Conclusion

Although yearly fluctuations existed with respect to both the numbers of articles and statements concerned with the objectives for teaching secondary school chemistry that appeared in the literature of the 1918-1972 period, the number of distinct objective types remained fairly constant. Sixteen of the eighteen identified were found in the literature of all six subperiods. In addition, no objective appeared in the literature of later subperiods that was not present in that of subperiod 1.

Most of the changes with respect to the most frequently cited objectives occurred during subperiods 4, 5, and 6. Prior to subperiod 4, six objective types ("scientific methods of thinking", "major facts, principles, concepts, or fundamentals", "specific topics in chemistry", "scientific habits or attitudes", "the applications of chemistry to daily life", and "processes, skills, and techniques of inquiry") were always the six most frequently referred to in the literature. During subperiod 4 citations involving the "career development" aspect of instruction in chemistry increased to 13.0 percent (second in frequency) while those involving " the application of chemistry to daily life" decreased to 2.6 percent (14th). Other objectives that increased in frequency of citations to become prominant during the final subperiods were those concerned with "the nature of science and scientists" and "sociological implications". These were ranked second and fourth respectively during subperiod 6.

Although this study does not mean to suggest that the objectives cited as prevalent in the literature were actually incorporated in the classroom, it is believed that an adequate body of information reflecting concern for the development of good secondary school chemistry teaching was available to the classroom teacher during the years in question.

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TABLE 1.--Numerical ranking of statements of objectives of secondary school chemistry teaching found in periodical literature by type, subperiod, and authorship: 1918-1972

Rank	Objective and Authorship	Subperiod 1	2	3	4	5	6
1.	Scientific methods of thinking						
	All authors	2	1.5	1	1	1	1
	Secondary	3	1	2	2	2	5
	Higher	1	2	1.5	1	1	1
	Miscellaneous	1.5	2.5	13	2	5	8.5
2.	Specific topics in chemistry						
	All authors	1	5	2	3	4	5
	Secondary	1	2	1	1	1	1
	Higher	9	13	7.5	6	6.5	11
	Miscellaneous	14.5	16.5	13	12.5	16	8.5
3.	Major facts, principles, concepts, or fundamentals						
	All authors	3	3	4	5	3	3
	Secondary	2	6	5.5	3.5	3	9.5
	Higher	2	3	3	5	3	3
	Miscellaneous	1.5	4	2	3	2	2.5
4.	Scientific habits or attitudes						
	All authors	4	1.5	3	4	5	6
	Secondary	5	3	3	5	6	9.5
	Higher	3	1	1.5	2	4	5
	Miscellaneous	3	1	13	6.5	11	15
5.	Career development						
	All authors	9	7	7	2	2	8
	Secondary	9	7.5	7	3.5	4	9.5
	Higher	6.5	6.5	4.5	3	2	7.5
	Miscellaneous	8	10	5.5	1	1	4.5

TABLE 1 .--Continued

Rank	Objective and Authorship	Subperiod 1	2	3	4	5	6
6.	Processes, skills, and techniques of inquiry						
	All authors	6.5	6	6	6	6.5	9.5
	Secondary	7.5	5	5.5	6	5	5
	Higher	5	5	6	4	6.5	7.5
	Miscellaneous	14.5	16.5	13	8.5	8	15
7.	Sociological implications						
	All authors	12.5	8	8	8	9	4
	Secondary	14.5	11	11.5	9.5	15.5	5
	Higher	11	6.5	4.5	8	8	4
	Miscellaneous	14.5	2.5	2	8.5	8	1
8.	The applications of chemistry to daily life						
	All authors	5	4	5	14	14.5	12
	Secondary	4	4	4	12	17.5	9.5
	Higher	4	4	7.5	11.5	14	12.5
	Miscellaneous	8	10	2	10.5	8	4.5
9.	Aesthetic aspects						
	All authors	8	10.5	10.9	9	10.5	9.5
	Secondary	7.5	9.5	14.5	9.5	11.5	5
	Higher	6.5	11	9	8	12.5	9
	Miscellaneous	8	10	13	15	5	8.5
10.	The nature of science and scientists						
	All authors	16	14	12.5	11.5	7	2
	Secondary	16.5	13.5	9.5	15.5	7	2
	Higher	15.5	14.5	13.5	11.5	5	2
	Miscellaneous	14.5	10	13	4.5	5	2.5

TABLE 1 .--Continued

Rank	Objective and Authorship	Subperiod 1	2	3	4	5	6
11.	Political implications						
	All authors	17	15	9	7	8	7
	Secondary	14.5	16	9.5	8	8.5	15
	Higher	17	16.5	10.5	10	9	6
	Miscellaneous	14.5	10	5.5	4.5	3	8.5
12.	Appreciations						
	All authors	10	9	10.5	11.5	13	16.5
	Secondary	10.5	7.5	8	12	13.5	15
	Higher	10	8	15.5	8	11	17
	Miscellaneous	14.5	10	5.5	14	16	8.5
13.5	Interest and hobby development						
	All authors	6.5	10.5	16	11.5	12	15
	Secondary	6	9.5	14.5	7	10	15
	Higher	8	11	15.5	14	10	15
	Miscellaneous	4.5	10	13	14	16	15
13.5	Philosophical considerations						
	All authors	11	12.5	15	11.5	10.5	11
	Secondary	10.5	13.5	14.5	12	8.5	5
	Higher	13	11	13.5	13	12.5	10
	Miscellaneous	4.5	5	13	6.5	11	15
15.	Economic aspects						
	All authors	15	16.5	14	15	14.5	13
	Secondary	16.5	18	17.5	14	11.5	15
	Higher	14	14.5	10.5	15.5	17.5	12.5
	Miscellaneous	14.5	10	13	10.5	11	8.5

TABLE 1 .--Continued

Rank	Objective and Authorship	Subperiod 1	2	3	4	5	6
16.	A fund of useful information						
	All authors	14	12.5	12.5	16	18	18
	Secondary	12.5	12	11.5	17	17.5	15
	Higher	15.5	9	12	15.5	17.5	18
	Miscellaneous	8	16.5	13	14	16	15
17.	Study skills						
	All authors	12.5	16.5	17	18	16.5	16.5
	Secondary	12.5	16	17.5	17	13.5	15
	Higher	12	16.5	17	18	15.5	16
	Miscellaneous	14.5	16.5	5.5	17	16	15
18.	Research and creativity						
	All authors	18	18	18	17	16.5	14
	Secondary	18	16	14.5	15.5	15.5	15
	Higher	18	18	18	17	15.5	14
	Miscellaneous	8	10	13	17	13	15

TABLE 2.--Percentage ranking of statements of objectives of secondary school chemistry teaching found in periodical literature by type, subperiod, and authorship: 1918-1972

Rank	Objective and Authorship	Subperiod 1	2	3	4	5	6
1.	Scientific methods of thinking						
	All authors	13.8	14.7	14.8	17.8	14.9	14.8
	Secondary	11.3	15.9	15.3	14.8	12.9	6.9
	Higher	15.1	13.5	15.6	22.3	17.9	16.8
	Miscellaneous	20.0	14.8	0.0	12.0	7.8	4.8
2.	Major facts, principles, concepts, or fundamentals						
	All authors	13.3	10.0	10.7	10.1	12.1	10.9
	Secondary	11.9	9.4	9.6	11.4	12.0	3.4
	Higher	14.1	10.5	10.9	8.8	11.2	11.6
	Miscellaneous	20.0	11.1	20.0	10.3	15.6	14.2
3.	Specific topics in chemistry						
	All authors	15.4	8.9	13.7	11.7	8.4	6.7
	Secondary	27.5	15.4	23.3	23.6	17.5	34.4
	Higher	4.7	3.0	5.5	4.7	5.6	3.4
	Miscellaneous	0.0	0.0	0.0	1.7	0.0	4.8
4.	Scientific habits or attitudes						
	All authors	9.8	14.7	13.3	10.3	7.3	6.3
	Secondary	8.1	14.5	12.0	8.7	6.4	3.4
	Higher	10.9	14.5	15.6	12.9	8.7	7.3
	Miscellaneous	10.0	18.5	0.0	6.8	3.9	0.0
5.	Career development						
	All authors	5.0	4.9	6.4	1[illegible]	14.4	5.3
	Secondary	3.7	4.0	4.8	11.4	11.1	3.4
	Higher	6.2	6.0	7.8	11.7	15.3	5.1
	Miscellaneous	5.0	3.7	10.0	20.6	17.6	9.5

TABLE 2 .--Continued

Rank	Objective and Authorship	Subperiod 1	2	3	4	5	6
6.	Processes, skills, and techniques of inquiry						
	All authors	5.8	8.2	8.0	8.2	7.0	4.9
	Secondary	4.5	10.0	9.6	6.7	10.1	6.9
	Higher	7.3	7.5	7.0	10.5	5.6	5.1
	Miscellaneous	0.0	0.0	0.0	5.1	5.8	0.0
7.	The applications of chemistry to daily life						
	All authors	9.0	9.4	8.3	2.6	1.9	3.5
	Secondary	10.2	10.4	10.4	2.0	0.0	3.4
	Higher	8.3	9.0	5.5	2.4	2.0	3.0
	Miscellaneous	5.0	3.7	20.0	3.4	5.8	9.5
8.	Sociological implications						
	All authors	2.2	4.7	5.3	3.7	3.6	10.6
	Secondary	1.0	2.2	1.6	2.7	0.9	6.9
	Higher	3.6	6.0	7.8	4.1	4.6	9.9
	Miscellaneous	0.0	14.8	20.0	5.1	5.8	23.8
9.	The nature of science and scientists						
	All authors	1.0	2.0	2.2	2.9	7.0	13.4
	Secondary	0.5	1.3	2.4	0.6	5.5	17.2
	Higher	1.5	2.5	2.3	2.4	7.6	12.9
	Miscellaneous	0.0	3.7	0.0	8.6	7.8	14.2
10.	Aesthetic aspects						
	All authors	5.5	3.3	2.6	3.1	3.3	4.9
	Secondary	4.5	3.1	0.8	2.7	2.7	6.9
	Higher	6.2	3.5	4.6	4.1	2.5	4.7
	Miscellaneous	5.0	3.7	0.0	1.7	7.8	4.8

TABLE 2 .--Continued

Rank	Objective and Authorship	Subperiod 1	2	3	4	5	6
11.	Political implications						
	All authors	0.7	1.5	3.4	4.5	5.3	5.6
	Secondary	1.0	0.9	2.4	4.0	4.6	0.0
	Higher	0.5	2.0	3.9	3.5	4.2	6.4
	Miscellaneous	0.0	3.7	10.0	8.6	11.7	4.8
12.	Interest and hobby development						
	All authors	5.8	3.3	1.1	2.9	3.1	1.4
	Secondary	5.2	3.1	0.8	4.7	3.7	0.0
	Higher	5.7	3.5	1.5	1.7	3.5	1.7
	Miscellaneous	10.0	3.7	0.0	1.7	0.0	0.0
13.	Philosophical considerations						
	All authors	3.0	2.6	1.5	2.9	3.3	3.9
	Secondary	2.7	1.3	0.8	2.0	4.6	6.9
	Higher	2.6	3.5	2.3	2.3	2.5	3.8
	Miscellaneous	10.0	7.4	0.0	6.8	3.9	0.0
14.	Appreciations						
	All authors	3.5	4.4	2.6	2.9	2.2	1.0
	Secondary	2.7	4.0	3.2	2.0	1.8	0.0
	Higher	4.7	5.0	1.5	4.1	3.0	0.8
	Miscellaneous	0.0	3.7	10.0	1.7	0.0	4.8
15.	Economic aspects						
	All authors	1.2	1.3	1.9	1.5	1.9	2.8
	Secondary	0.5	0.0	0.0	1.3	2.7	0.0
	Higher	2.0	2.5	3.9	1.1	1.0	3.0
	Miscellaneous	0.0	3.7	0.0	3.4	3.9	4.8

TABLE 2.--Continued

Rank	Objective and Authorship	Subperiod 1	2	3	4	5	6
16.	A fund of useful information						
	All authors	1.7	2.6	2.2	0.7	0.5	0.0
	Secondary	1.6	1.8	1.6	0.0	0.0	0.0
	Higher	1.5	4.0	3.1	1.1	1.0	0.0
	Miscellaneous	5.0	0.0	0.0	1.7	0.0	0.0
17.	Research and creativity						
	All authors	0.2	1.1	0.3	0.5	1.4	2.1
	Secondary	0.0	0.9	0.8	0.6	0.9	0.0
	Higher	0.0	1.0	0.0	0.5	1.5	2.5
	Miscellaneous	5.0	3.7	0.0	0.0	1.9	0.0
18.	Study skills						
	All authors	2.2	1.3	0.6	0.0	1.4	1.0
	Secondary	1.6	0.9	0.0	0.0	1.8	0.0
	Higher	3.1	2.0	1.7	0.0	1.5	1.2
	Miscellaneous	0.0	0.0	10.0	0.0	0.0	0.0